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New solid state silicon arrays which outperform photon counting PMTs under extreme low light fluxes are described. The results of the evaluation of the spectroscopically pertinent characteristics of several charge transfer device (CTD) detectors are presented. The characteristics of these multichannel detectors include peak quantum efficiencies exceeding 80%, read noises of approximately ten charge carriers and virtually no dark current. The potential for these non-intensified silicon devices to outperform PMTs in many low light level situations is demonstrated. The signal-to-noise ratios for several CTD detectors are contrasted to the signal-to-noise ratio performance of the best photon counting PMTs for a variety of low flux situations.

Two approaches to creating a single element detector with the same optical format and larger dynamic range than common photon counting PMTs are described. The results of the evaluation of a prototype large single element charge injection device are presented. Combining a 10^6 simple dynamic range with the ability to vary integration times over (over)

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four orders of magnitude allows this detector to quantify photon fluxes ranging over ten orders of magnitude. The other approach to using CTDs as a direct replacement for PMTs involves a process called binning employed with charge-coupled devices. This technique combines photogenerated charge from several detector elements forming an effectively larger detector which can be read in a single low noise read. The superior performance of several charge-coupled device detectors operated in a highly binned mode as compared to other low light detectors is demonstrated.

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Comparison of Charge Transfer Device and Photomultiplier Tube Performance for Extremely Low Photon Fluxes

by

J.V. Sweedler and M.B. Denton

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COMPARISON OF CHARGE TRANSFER DEVICE AND PHOTOMULTIPLIER TUBE PERFORMANCE FOR EXTREMELY LOW PHOTON FLUXES

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Index Headings: Charge transfer devices, charge injection devices, charge coupled devices, photon counting photomultiplier tubes, detection comparison

ABSTRACT

New solid state silicon arrays which outperform photon counting PMTs under extreme low light fluxes are described. The results of the evaluation of the spectroscopically pertinent characteristics of several charge transfer device (CTD) detectors are presented. The characteristics of these multichannel detectors include peak quantum efficiencies exceeding 80%, read noises of approximately ten charge carriers and virtually no dark current. The potential for these non-intensified silicon devices to outperform PMTs in many low light level situations is demonstrated. The signal-to-noise ratios for several CTD detectors are contrasted to the signal-to-noise ratio performance of the best photon counting PMTs for a variety of low flux situations.

Two approaches to creating a single element detector with the same optical format and larger dynamic range than common photon counting PMTs are described. The results of the evaluation of a prototype large single element charge injection device are presented. Combining a 10^6 simple dynamic range with the ability to vary integration times over four orders of magnitude allows this detector to quantify photon fluxes ranging over ten orders of magnitude. The other approach to using CTDs as a direct replacement for PMTs involves a process called binning employed with charge-coupled devices. This technique combines photogenerated charge from several detector elements forming an effectively larger detector which can be read in a single low noise read. The superior performance of several charge-coupled device detectors operated in a highly binned mode as compared to other low light detectors is demonstrated.

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